

Antimicrobial Resistance of
Staphylococcus aureus in
Companion Animals in Southern
Arizona

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History

- Methicillin-resistant *S. aureus* (MRSA)
 - Initial identification of MRSA in humans in 1961 (Leonard et. al, 2006)
 - First documented case of animal MRSA infection in 1972 (Devriese et. al, 1972)
 - Milk samples from mastitic cows
 - Today, *mecA* gene found in animal isolates matches gene found in human isolates (Malik et. al, 2006)
- Vancomycin-resistant *S. aureus* (VRSA)
 - Vancomycin-resistant *Enterococcus* (VRE) first reported in 1988 (Courvalin, 2006)
 - Rapid emergence of VRSA
 - Late 1990's, VRSA detected in the human community (Witte, 2004)
 - Today, VRSA in the animal community
 - Scope?

Scope

- *S. aureus* as a common invasive pathogen
 - Recovered in approximately 10% of samples from dogs and cats (Leonard et. al, 2006)
- Recent Studies
 - 561 MRSA isolates found in companion animals in the United Kingdom (2003-2006) (Rich et. al, 2006)
 - 23.5% of canine *S. aureus* isolates were resistant to methicillin in Tennessee (2005) (Jones et. al, 2007)
 - CDC report on 2005 notifiable human diseases reported 3 cases of VRSA (CDC, 2007)
- MRSA and VRSA isolates resistant to most major classes of antimicrobials
 - Glycopeptides (vancomycin) used to treat MRSA
 - Prevalence of resistance increasing (Hyatt, 2005)

Zoonotic Transmission

- In brief, recent studies reveal zoonotic transmission and cross-infection of MRSA is possible
 - MRSA in 10 veterinary personnel and 25 animal patients in Ireland (2003-2004)
(O'Mahony et. al, 2005)
 - Identical strains shared between personnel and patients
 - Veterinary personnel a high-risk population for acquiring and transmitting MRSA (Loeffler et. al, 2005)

Resistance

- Vertical evolution and horizontal evolution
- MRSA
 - Acquisition of *mecA* resistance gene that encodes for PBP2a protein (Tenover, 2006)
 - Decreased affinity for oxacillin and other beta-lactam antimicrobials
- VRSA
 - Acquisition of *vanA* transposon from VRE (Tenover, 2006)
- Inappropriate use of antimicrobials

What about in southern Arizona?



The Study

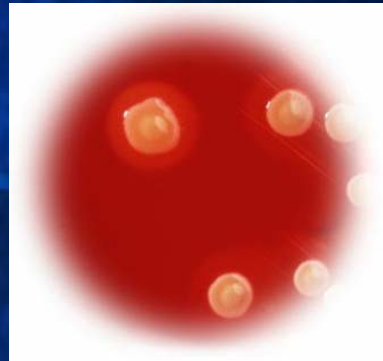
- March 2006 - February 2007
- Arizona Veterinary Diagnostic Laboratory submissions
- *S. aureus* isolates obtained from 18 animals
- Species: canine (16), feline (1), avian (1)
- Populations: veterinary clinics, pet households, the Humane Society of Southern Arizona, Pima Animal Care Center, the Desert Museum and the Sheriff's Department

Sources of *S. aureus* isolates

Species	Sex/Age	Population	Human Risk	Specimen	Pathological Diagnosis	Clinical Signs	Isolate Resistance
Canine	Female/1 yr	Humane Society	Staff, Veterinarians, Owners	Nasal Swab	N/A	Fever, nasal discharge	MRSA and VRSA
Canine	Male/1 yr	Pet, Vet Clinic	Staff, Veterinarians, Owners	Lung, Liver	Pneumonia, secondary bacteremia/sepsis	Non-responsive, castes in urine	MRSA and VRSA
Canine	Male/14 yrs	Pet, Vet Clinic	Staff, Veterinarians, Owners	Draining tract swab	N/A	Open draining tract	MRSA
Canine	Female/3 yrs	Pet, Sheriff's Dept.	Dept. Staff, Veterinarians, Owners	Lung, Liver	Fluid in lungs, drowned	Healthy , sudden death	<i>S. aureus</i>
Feline	Female/21 yrs	Pet, Vet Clinic	Staff, Veterinarians, Owners	Liver	Purulent bronchitis	No history provided	<i>S. aureus</i>
Avian	Male/Adult	Pet, Bird Clinic	Staff, Veterinarians, Owners	Choanal swab	N/A	Routine culture	<i>S. aureus</i>

Methods

- Bacterial isolation and identification
- Oxacillin agar screen
- Vancomycin agar screen
- Disk diffusion test
 - Oxacillin, cefoxitin and vancomycin
- Etest
 - Cefoxitin and vancomycin
- NCCLS preferred methods and susceptibility criteria



Resistance Criteria

- A *S. aureus* isolate is considered MRSA and/or VRSA if the isolate meets the resistance criteria for at least 2 of the 3 methods
 - MRSA: oxacillin agar screen, disk diffusion test, Etest
 - VRSA: vancomycin agar screen, disk diffusion test, Etest

Major Findings

- Four of 18 isolates were considered MRSA
 - 3/4 were confirmed by all three methods
 - MRSA: 17% to 22%
- Three of 18 isolates were considered VRSA
 - 2/3 were confirmed by all three methods
 - VRSA: 11% to 17%
 - All 3 VRSA isolates were also identified as MRSA
- Isolates resistant to many classes of antimicrobials
- MRSA/VRSA infected animals found in the presence of the following human populations: veterinarians, clinic/humane society staff, pet owners and zookeepers

Discrepancies

- Contradictions in test results
- Resolved by requiring each isolate to meet the resistance criteria of at least 2 of the 3 methods to be considered resistant

Antimicrobial susceptibility testing of *S. aureus* isolates

			Disk Diffusion Test (Resistant Result)												Etest (Resistant Result)					
Isolates	Oxacillin Agar Screen (Positive Result)	Vancomycin Agar Screen (Positive Result)	<i>Amox/Clav Acid</i>	<i>Ampicillin</i>	<i>Cefoxitin</i>	<i>Cephalothin</i>	<i>Clindamycin</i>	<i>Erythromycin</i>	<i>Gentamicin</i>	<i>Oxacillin</i>	<i>Penicillin</i>	<i>Tetracycline</i>	<i>Trimeth-sulf</i>	<i>Vancomycin</i>	<i>Ampicillin</i>	<i>Cefoxitin</i>	<i>Erythromycin</i>	<i>Gentamicin</i>	<i>Tetracycline</i>	<i>Vancomycin</i>
All <i>S. aureus</i> isolates (18/18)	4	3	2 (11%)	12 (67%)	1 (<1%)	2 (11%)	4 (22%)	2 (11%)	1 (<1%)	4 (22%)	13 (72%)	2 (11%)	7 (39%)	2 (11%)	12 (67%)	3 (17%)	2 (11%)	0 (0%)	3 (17%)	8 (44%)
<i>S. aureus</i> isolates without resistance (14/18) *	0	0	0	8	0	0	0	0	0	0	9	2	6	0	8	0	0	0	3	5
MRSA isolates (4/18)	4	3	2	4	1	2	4	2	1	4	4	0	1	2	4	3	2	0	0	3
MRSA and vancomycin-resistant isolates (3/18)	3	3	2	3	1	2	3	2	1	3	3	0	0	2	3	3	2	0	0	3

Limitations

- Small number of *S. aureus* isolates available for survey of resistance
- Unable to use more advanced, reliable methods for determining resistance
- Cannot confirm that zoonotic transmission involving the 4 resistant isolates has occurred

Solutions to Limitations

- Broader surveillance
- Use of more effective detection methods
 - Highly discriminatory, reproducible, standardized, based on a stable feature, widely available, inexpensive and performed satisfactorily in an epidemiological investigation (Weller, 2000)
 - Pulsed-field gel electrophoresis (PFGE)
- Collaboration with the medical community

Surveillance and Control

- Collaboration between animal owners, veterinary and medical community
- Use of effective detection methods
 - Understanding the mechanisms of resistance
 - Molecular methods preferred, such as PFGE
 - Methods must also be available for routine diagnostics
- Appropriate use of antimicrobials
- Use of aseptic techniques in clinics (Leonard et. al, 2006)

Take-Home Message

- MRSA and VRSA exist in Arizona
- There is a threat of zoonotic transmission and cross-infection
- Broader surveillance is needed, with the use of effective detection methods
- Attempts to control the prevalence of resistant *S. aureus* must extend outside of the veterinary and medical community
- New antimicrobials for treating MRSA/VRSA infections need to be developed for animals

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